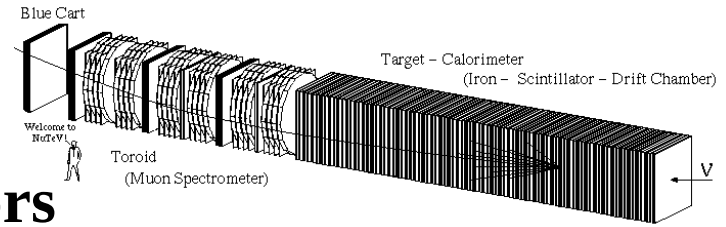
Liquid Scintillator for a 50 KTon Off-Axis Neutrino Detector



NuTeV

- **Why Liquid Scintillator?**
  - **Many examples of large detectors**
    - **Good performance – over long times**
    - **Proven calorimetry and tracking**
    - **Construction experience and costing**
    - **Minimal care needed**
  - **Low cost**
  - **Shape of container**
    - **Longer for more fiducial volume**
    - **Thicker for more light**
  - **Ease of installation**
    - **Light weight container**
    - **Pour in place**

MACRO

Kamland

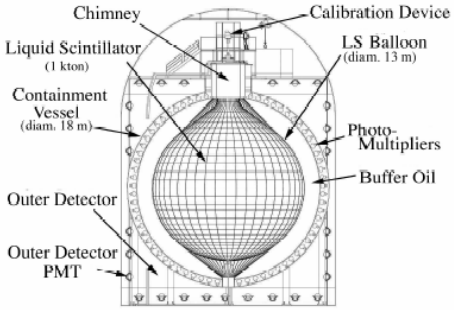


FIG. 1: Schematic diagram of the KamLAND detector.

Components – Extensively Tested for MINOS

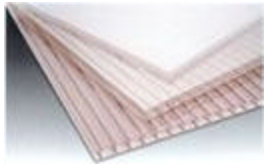
- **Bicron 517 L**

  Border et al, NIM A 463, 194-204 (2001)

  - **Good light yield**
  - **No chemical reactivity with other elements**
  - **Long experience**
  - **Low cost**
- **Kuraray wavelength shifting fibers**
  - **Good attenuation length**
  - **No reactivity with BC517L scintillator**
  - **MINOS experience**
- **Extruded PVC containers**
  - **Commercially available**
  - **Cell structure**
    - **Segmented**
    - **Strong**
  - **No reactivity with B517L scintillator**

Plastic Use in Construction

Deck Construction



Standard Widths	980, 1050, 1220, 1250, 2100 mm

A new truss bridge composed of recycled plastic was recently unveiled in Greene County, New York. The bridge, primarily for pedestrian use, can carry a 15-ton (30,000 lbs) emergency vehicle as shown in this picture.

Plastic Use in Agriculture

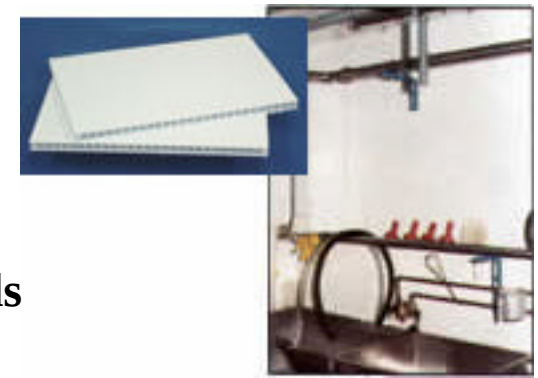
PolyDome Bulk Bins

Designed to Handle High-Moisture Corn and Soybeans

Size Specification Chart

Ton Size @ 40 lbs./cu. ft.	Cubic Feet	Bushel Capacity	Height	Diameter	Weight
.9	47	37	9’	68”	420 lbs.
1.5	75	60	9' 6"	74”	470 lbs.
2.5	130	104	11' 5"	74”	500 lbs.
3.5	180	144	13' 5"	74"	540 lbs.
4.5	220	176	12' 6"	96”	800 lbs.
6.5	325	260	16'	96"	850 lbs.
8.5	425	340	19' 6"	96”	950 lbs.

Utility sheds



walls/celings in milk houses

Important Costs

- **Scintillator**
  - **Mineral oil (tanker deliveries)** **$2.75/gallon**
  - **Pre-mixed fluors ($2300/55 gallon diluted @ 20:1 for BC517L)** **$2.09/gallon**
  - **Scintillator is $5.75/gallon** **$1.7M / kTon**
- **PVC extrusions**
  - **Die for specific shape** **$150 K**
  - **Extrusions** **$1.07/lb**
  - **Container is** **$2.4M / kTon**

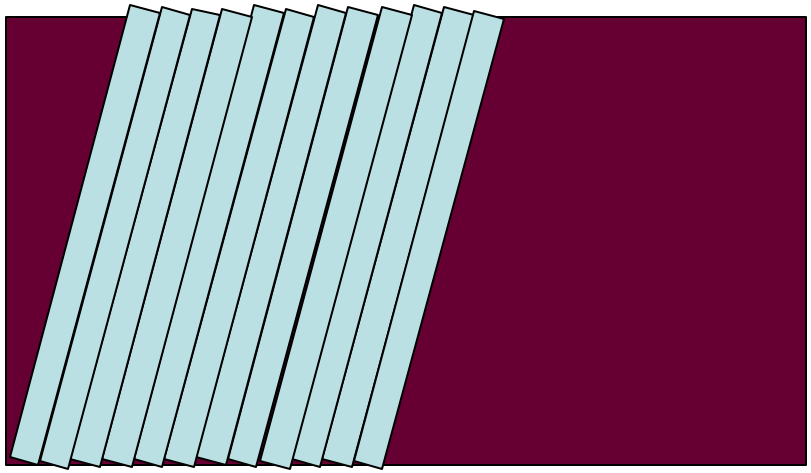
Replace Solid Scintillator - Signal

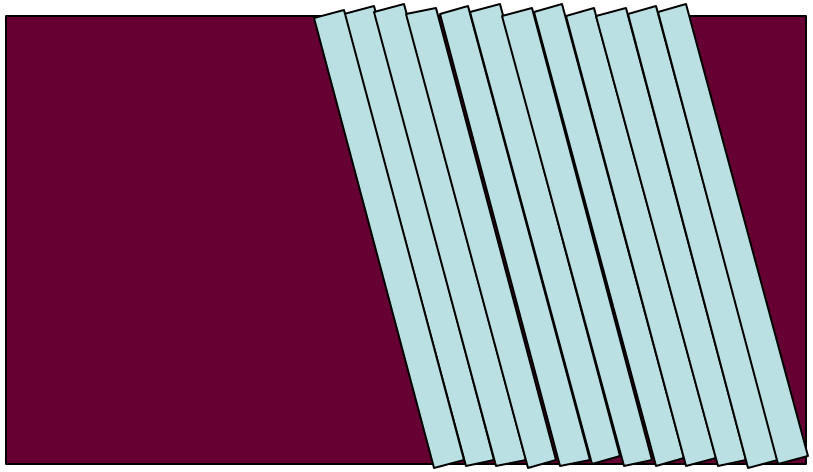
- **25 photons @ 8 m with 1.2 mm fiber with MINOS scintillator (1 cm)**
- **5 photons @ 20 m with 1.2 mm fiber with MINOS scintillator**
- **20 photons @ 20 m with 1.2 mm fiber U loop MINOS scintillator**
- **10 photons @ 20 m with 0.6 mm fiber U with MINOS scintillator**
- **20 photons @ 20 m with 0.6 mm fiber U with liquid scintillator (4 cm)**
- **25 photons @ 20 m with 0.75 mm fiber U with liquid scintillator**

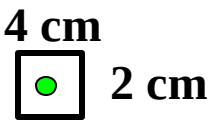
APD: 25 * .85 * 100 = 2100 electrons (noise 300)

PMT: 25 * .12 = 3 photo electrons

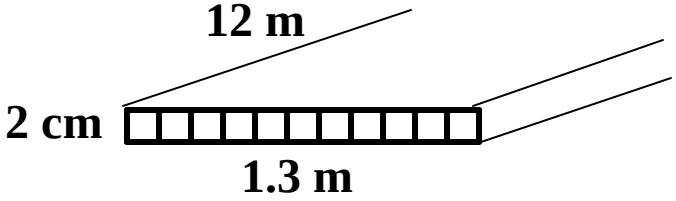
Straight Replacement







1 cell
1.5 mm outer wall
1 mm inner wall
WLS read out for scintillator

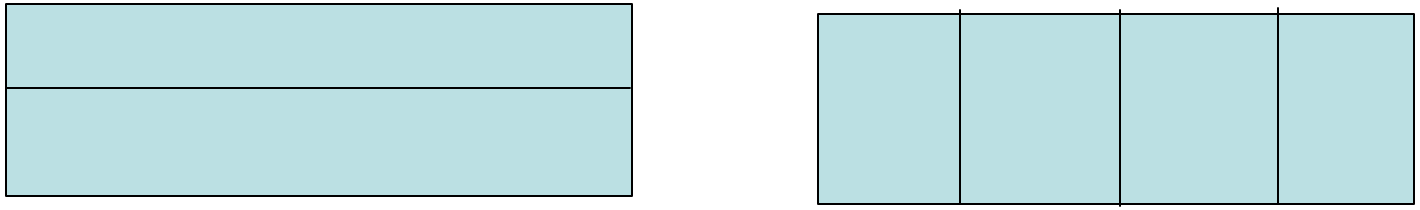


1 module
32 cells/module
1 scintillator layer/plane
0.09 tons/module (unfilled)

Cost = $72M with pmt (solid was $104M)
Cost = $60M with apd

Other Options

- **Longer modules for more fiducial mass**
  - **Can go to 20 m long with 4 cm x 4 cm cells**
  - **Cost increase = $6M**
- **Put into shipping containers**



2.4 m wide, 2.6m high, 6 m long

4.5 * number of channels

Cost = $79M (4 cm x 2 cm cell)
Cost = $75M (4 cm x 1 cm cell for short modules)

Better optimization possible

Better Optimization?